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CRM - Mitigating Flooding in VANET through Controlled Rebroadcasting Mechanism

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ABSTRACT

The Vehicular Adhoc Network (VANET) is realizing Intelligent Transportation System. VANET performs essential functions in road safety, accident detection and congestion reduction by enabling vehicles to broadcast messages. In case of emergency, vehicles broadcast an alert message to its neighbors and receives an alert message from its neighbors, causing an increase in the number of rebroadcasted messages and lead to flooding. The flooding will result in higher bandwidth utilization, drop of packets etc. and handling this flooding situation is an open issue. Thus, this paper proposes a novel technique for controlling the rebroadcasting of emergency messages to reduce the number of broadcasted or rebroadcasted messages in the VANET. Unlike the traditional rebroadcasting method, multipath nature of signal propagation inherent in the urban environment was taken into account. This method implies reducing the number of rebroadcasting messages to the minimum possible, but sufficient number for information coverage of the required area. The simulation of the proposed method assessed both qualitatively and

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quantitatively. It works better than most of the proposed current techniques.

1. Introduction

Wireless technology is one of the most famous networking technologies to interconnect different devices for exchange data between them. The wireless technology is incorporated in vehicles to develop and realize the Intelligent Transportation Systems (ITS) ITS trying to make vehicle commute safe. In VANET networks, which are totally, depends on wireless technology and uses broadcasting technique to disseminate messages among the network nodes. Vehicular Ad hoc Network (VANET) 's main function is to prevent traffic accidents through fast and reliable broadcasting of emergency messages. For this purpose, various protocols and standards proposed by industry and academia. However, the strong dynamics of VANETs, sometimes associated with high vehicle densities in urban areas, impose some limitations on the use of standard networking solutions used in static or low mobility situations (Mohammed, Andrii, Ahmed, Olha, & Owaid, 2019). The use of Road Side Units (RSU) and fixed infrastructure improves message delivery and reduces bandwidth utilization by reducing the need for multi-hop retransmission; Upon receipt of an emergency message, the RSU-based infrastructure can partially support the function of (i) reporting alarms and (ii) displaying warning messages on dedicated dashboards. Many different techniques may be used in VANET to broadcast packets inside the network. Figure 1. Shows basic approached to build up VANET system based on IEEE 802.11p

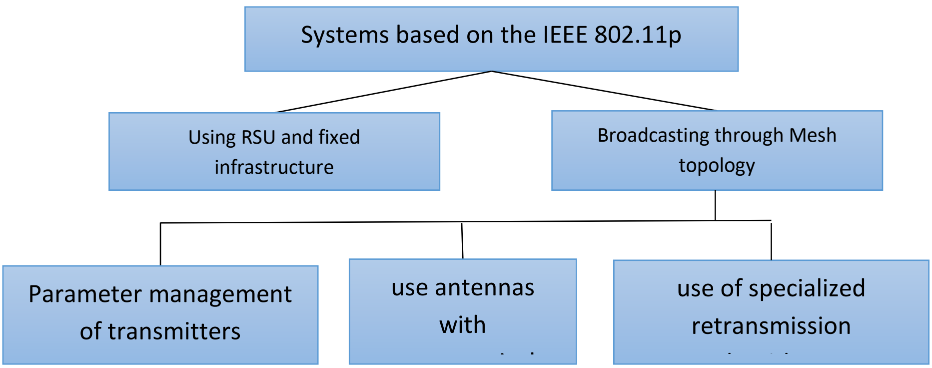

Figure 1. VANET system

To overcome network congestion, new methods of rebroadcasting messages control are applied. This research work aims to develop a novel method for controlling the rebroadcasting of the emergency messages known as Controlled Rebroadcasting Mechanism (CRM). This novel method would reduce bandwidth utilization, normalized message transmission delay, minimized packet drop, and fewer retransmitted packets in VANET. The proposed mechanism depending on the IEEE 802.11p and using MAC layer information to improve network performance (Al-Alkawi, Hanfesh, & Rauof, 2019).

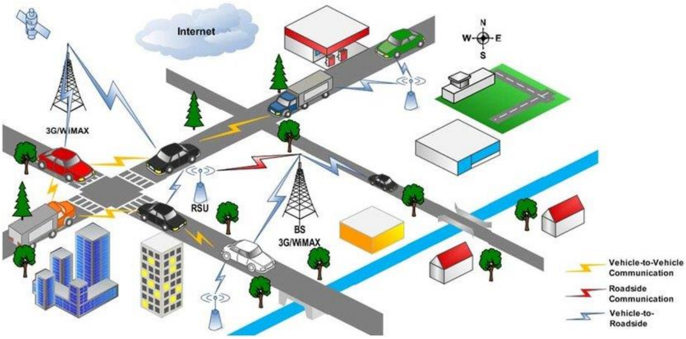

Figure 2. V2V communication architecture

2. Related Work

In vehicular networks, message dissemination is critical to inform vehicles about problems that may affect them quickly. However, massive dissemination of messages is prone to cause broadcast storm problems if no mechanisms are introduced to prevent it. To deal with network congestion, specialized techniques of re-transmission process control are applied. The Edge-Aware Epidemic Protocol's (Baumann, 2004) main function is to send message across all the vehicles. Each vehicle will have its geographic position through this particular protocol type. The total number of transmissions from source to destination takes place in the given time. EAEP will decide whether the nodes are retransmitting the new broadcast message that is received. This protocol is having the drawback of creating high number of data transmission and increased delay in transmission. The authors(Bhat & Shah, 2012) proposed a broadcasting protocol based on vehicles' position to disseminate emergency messages through a large VANET. The idea of the proposed protocol is to communicate a message in its region of Interest, so that the vehicles concerned with the message are involved in it can be obtained. In contrast, it can decrease needless broadcasting Channel services are used effectively and efficiently. The suggested protocol is accessible not only for highway situations, but also applicable in the urban environment. It let the vehicles to make decision independently for broadcasting the message when it receives. The main drawback of this protocol is not aware of the bandwidth utilization which leads to packet drop during highly congested traffic in the network. The author(Kim et al., 2015) divides nodes into three groups, such as outer node, inner node, and protected ring node, according to reception power, while the inner node represents the nearest nodes from the source node. External nodes are far from the original node, and nodes in the protected ring are called nodes that have a preferred distance from the source node. The node must calculate the difference between the received power and the receive threshold, called the receive power threshold (rxDiff). In such a scenario, two new thresholds must be defined one at a time to indicate the internal nodes of the protected ring and the second is to designate protected ring nodes from external nodes, they may be called the Inner Border Threshold (IBT). The Outer Border threshold (OBT) and the maximum transmission area is called the third natural limit (maxTxRange). The main disadvantage of SRB is, increased control packet overhead. Preferred Group Broadcast protocol (Sospeter et al., 2019) aims to avoid the problem caused by the storm transmitting route requests. In PGB protocol, all nodes will sense the level of signal strength from neighbor node broadcasting. The nodes will retransmit the message to other nodes those have shortest timeout. The main disadvantage of SRB is, reliability factor. The authors (Bi et al., 2015) proposed a Multi-Hop Broadcast Protocol for Emergency Message Dissemination in Urban vehicular Ad Hoc Networks (MBP). This work aims to reduce the delay in the transmission of emergency messages and reduce the redundancy of messages. The flood protocol was used at VANET to efficiently disseminate information for active safety applications such as vehicle speed and location. The main disadvantage of this protocol is that the vehicle has to wait for some time to decide whether to retransmit or not suitable for emergency situations. Beacon messages should be used to alert

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the neighbors once the emergency event occurs. In (Bhat & Shah, 2012) authors investigated multi-hop routing in ad-hoc network problems. IEEE 802.11p and other vehicle network specifications encourage them to send commonly used messages called beacons. The authors proposed a new algorithm, the rate adaptation algorithm (RAA), which behaves like automatic rate fallback (ARF). They used an RTS / CTS handshake (send / cancel request) when it was necessary to decide to change the physical baud rate. Because 802.11 uses the Distributed Coordination Function (DCF) mechanism to access media, collisions can occur if two or more stations want to transmit data simultaneously. The work proposed by (Kim et al., 2015) is a Coordinated Multi-Channel Media Access Control (C-MAC) protocol used in Vehicular Ad-hoc Network. This research aims to develop a protocol for transmitting safety information by coordinating road units with each other and maximizing bandwidth and reducing latency by providing controversial broadcasts. The developed C-MAC protocol consists of three slots. The first window is the length information broadcast phase (LIBP). The second interval is the safety Message phase (SMP). The third interval is the Channel Reservation Stage (CRP). This protocol allows the dispatch of service messages and security messages without conflict. The proposed C-MAC has a longer interim period for channel reservation and transmission time, which is negative. In the paper (Sospeter et al., 2019), the authors proposed an effective and efficient adaptive probability data dissemination protocol (EEAPD). EEAPD uses the redundancy ratio metric to explain the connection between vehicles and road segment in rebroadcasting decisions. The EEAPD protocol takes account of the number if road segments for deciding which nodes are suitable for rebroadcasting emergency message. The last segment of the road is considered to be in the transmission range because of having the Probability of low vehicle number. This research work did not consider the hidden node and obstacles which could affect the probability of reaching more number of vehicles in the VANET.

3.Controlled Rebraodcasting Mechanism (CRM)

Taking into account the previously obtained calculated data of the informing distance, it is obvious that in order to achieve the D_{inf}^{max} informing distance, it is necessary to use multistep messages rebroadcasting. In turn, this will lead to an increase in the load on the network, increasing with each new rebroadcasting. Considering that the importance of the transmitted information decreases with distance from the source node, it is quite natural to conclude that it is necessary to limit the TTL packet lifetime (TimeToLive) in several steps (transfers between nodes). In the process of evaluating the required number of retransmissions, it should be noted that setting the TTL value too small will lead to the premature discarding of packets until they reach the required information distance D_inf^min . Thus, the solved problem of determining the required number of shipments can be formulated as:

$$TTL \rightarrow min_{U_a} | D_{inf}^{min}, D_{inf}^{max}, t_{inf}^{max} \quad \text{------- (1)}$$

To assess the distribution distance of broadcast messages, it is necessary to take into account many factors, such as the density of vehicles, their location and the nature of the terrain, affecting the occurrence of reflected signals. In (Baumann, 2004; Nekovee & Bogason, 2007; Tian et al., 2018) it is proposed to use the analytical apparatus obtained in(Bi et al., 2015) and which allows one to estimate, taking into account the above factors, the cumulative probability distribution function CDF (CumulativeDistributionFunction) message transmission distance as:

$$F_R(a) = 1 - P(\gamma(a) > \varphi) \quad \text{---------- (2)}$$

where R is the interaction distance;
(γ(a)>ϕ) - the probability that the signal-to-noise ratio SNR (Signal-to-NoiseRatio) γ(a) above threshold ϕ, necessary for successful reception of the message. Substituting the probability density function of the Nakagami model into expression ,we can obtain the formula for calculating the CDF for various propagation conditions of the signal, depending on the area on which the transmission is performed.
In this case, the average value of the information distance can be obtained from as:

$$E[R] = \int_0^{\infty} (1 - F_R(a)) da \quad \text{----------(3)}$$

The algorithm proposed in this paper belongs to the group of probabilistic, parametric broadcasting methods. The basic principle of the proposed algorithm is to generate a delay for incoming broadcast messages, the value of which varies based on the SINR

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value measured by each node when a message is received. The calculation of the delay interval is made individually for each received packet. During the delay time, the node continues to work in stationary mode and in the event of a duplicate message, both messages are marked as prohibited for further forwarding. Also, this technique controls the rebroadcasting of emergency messages to limit the usage of bandwidth (Awasthi & Sharma, 2020). This is done using factors like Time to Live (TTL), vicinity of vehicles, current location, etc. If an accident generates emergency message and broadcast it, the immediate vehicles rebroadcast it and the second level vehicles, which control the next rebroadcasting. For that, the vehicle will calculate the time to live and the vicinity of the vehicles update that information in the emergency message and rebroadcast it, the next layer vehicles calculate TTL validity and the current location within area. If the current location value is greater than ER, then it will be rebroadcasted or drop the packet. By this, the vehicle within their farthest distance in the vicinity will rebroadcast, thus the rebroadcasting of emergency message is controlled, and the less of bandwidth is achieved. The following are the steps followed by CRM.

Start: When a vehicle faces an obstacle ,

STEP-1: it disseminate an emergency message immediately of other neighbor nodes through its vicinity

STEP-2: broadcast packet will be received by neighbor node,

STEP-3: every packet has a Time-to-Live (TTL) value if the TTL of the packet was less than the TTLmax which is defined as a static value.

STEP-4: the packet will be put in a buffer ,

STEP-5: if the the buffer was free then

STEP-6: the delay time will be set and the packet will not be the counter will be ready for sending the packet for other node , else the buffer was not free , then

STEP-7: it checks the buffer if it contains a packet with the same ID then

STEP-8: it checks the duplication flag (which is the variable defined as a Boolean and set as a false value , if the flag value was false then

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STEP-9: it will be converted to True and the packet will be removed and the packet will not be rebroadcasted , otherwise if the flag value was false then (
STEP-10: the packet will be put in delay counter until the packet will it ends. If there was no packet with the same ID in buffer then
STEP-11: the delay timer will be set and the duplication flag will set to false and
STEP-12: the time will be initialized to prepare for rebroadcasting packet to other neighbour node. On the other hand, if the TTL was greater than TTLmax then
STEP-13: the packet will be accepted and will not be rebroadcasted to other neighbour node in the segment vicinity.
End

Table 1. Mechanism of Controlled Rebroadcasting

This approach avoids the need to parse each packet in the process of establishing the fact of duplication to determine its identifier, which significantly increases the performance.

4. Performance Evaluation

The following graphs give the comparison of proposed method with three other methods which are mentioned in literature survey. The figure 4.1 gives the comparison in terms of number of vehicles the emergency message crossed. From the graph it is proven that the proposed method makes the emergency message crosses more vehicles so that more number of vehicles is informed about the emergency.

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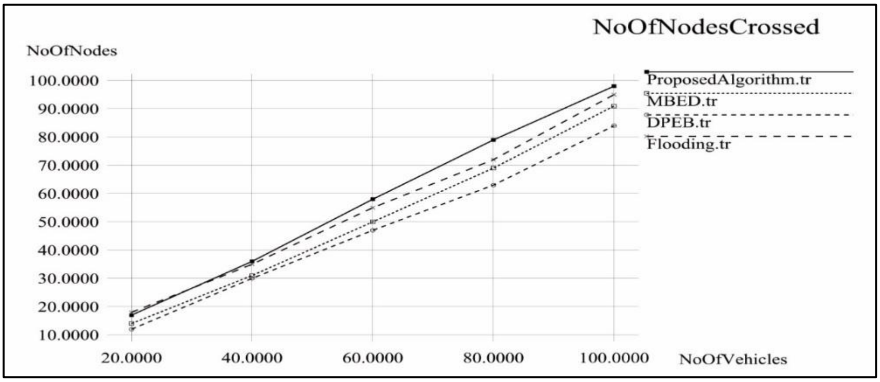

Figure 4.1. Number of Nodes Crossed compared

On the other hand, the throughput is also one of the important issues which should be studied in VANET. As illustrated in figure 4.2 the comparison in terms of throughput of vehicles the emergency message crossed. From the graph, it is proven that the proposed method makes better bandwidth utilization compared with other methods.

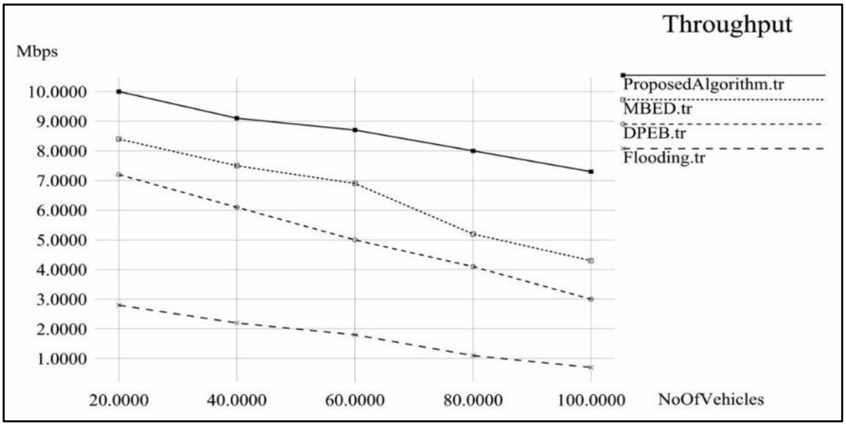

Figure 4.2. Throughput

Packet Delivery Ratio (PDR) which is defined as the ratio between the received packets by the destination and the generated packets by the source. In figure 4.3 which is showing the comparison in terms of number of vehicles packet delivery ratio of emergency messages. From the graph, it is proven that by applying proposed method the packet delivery ratio will be increased comparing with other methods.

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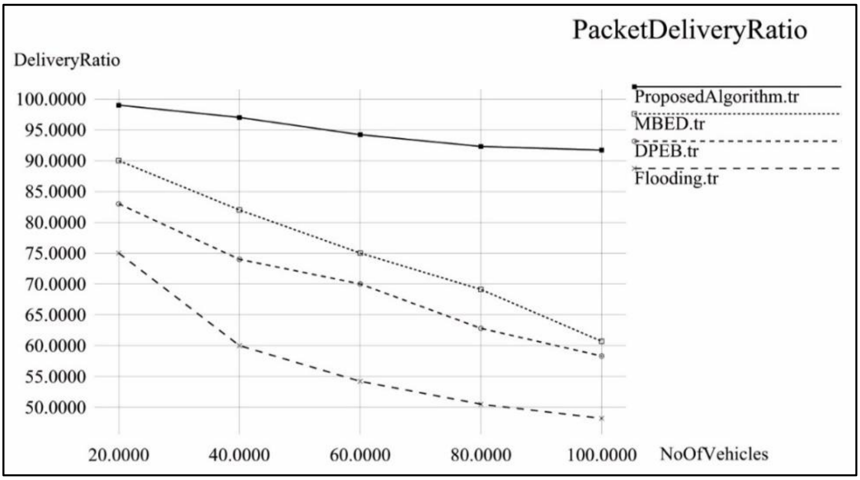

Figure 4.3. Packet Delivery Ratio (PDR)

5.Conclusion

In Wireless Access Vehicular Environment infrastructure-less VANET rebroadcasting traffic distribution system in terms of costing and reliability, as well as message duplication cause increase the load on the network. The important characterized particular vehicular networks (mobility vehicles, critical constrains mobility scenario and alert rebroadcasting variable communication conditions) has research challenges on the rebroadcasting traffic distribution system. From this proposed solution the idea can be reiterated that the rebroadcasting traffic information in wireless access vehicular environment creates the better performance in increasing throughput, reducing delay and collision .The proposed novel decision rebroadcasting algorithm is creates the emergency message for first layer vehicles which follows the MAC layer in IEEE 802.11p standard and maintain the Time to Live threshold. Through the maximum transmission range and vehicle speed the delay time has reduced in the proposed algorithm.

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پوخته

VANET هەژمار دەکرێ بە سیستەمی گواستنەوەی زیرەک ITS. VANET بنەما سەرەکیەکانی سەلامەتی ڕێگا و ڕێگری کردن لە لە ڕووداوی هاتوچۆ و کەمکردنەوەی پێکدادان لەخۆدەگری لە ڕێگای کاراکردنی سیستەمی بلاوکردنەوەی پەیامی خودکار. ئۆتۆمبیلەکان پەیامی ئاگاردکردنەوە بڵاودەکەنەوە لە کاتی ڕوودانی ڕووداوی هاتوچۆ لەنێوان ئۆتۆمبێلە هاوسێ یەکان بەشێوەیەکی خودکار کە ئەمەش دەبێتە هۆی زیادبوونی ژمارەیەکی ئێجگار زۆری پەیامەکان لە کاتێکدا هەر ئۆتۆمبێلێک پەیام دەنێری لە هەمان کاتدا دەبێتە هۆی ڕوودانی دیاردەی لافاوی پەیام (Flooding) و کە ئەمەش دەبێتە هۆی زیادبوونی باندی بەکارهاتوو وەهەروەها نەگەیەشتنی پەیامەکان یان نەگەیشتنی پەیام لەکاتی دیاری کراو.

ئەم لێکۆڵینەوەیە " CRM - Mitigating Flooding in VANET through Controlled Rebraodcasting Mechanism" کار لەسەر کەمکردنەوەی ژمارەی پەیامەکان و هەروەها ڕیگری کردن لە دوبارە ناردنەوەی پەیامەکان دەکات بە بەکارهێنانی ئەلگۆریثمی (algorithm) تایبەت . دوای بە پراکتیک کردنی مێتۆدەکە بە بەکارهێنانی سیمیولەیتەر (Simulator) دەرکەوت کە ئەنجامی باشتر بە دەست هات بە بەراورد لەگەل میتۆدەکانی پێشوتر.

الملخص:

تحقق شبكة Adhoc للمركبات (VANET) نظام نقل ذكي. تؤدي VANET وظائف أساسية في مجال السلامة على الطرق واكتشاف الحوادث وتقليل الازدحام من خلال تمكين المركبات من بث الرسائل في حالة الطوارئ ، تبث المركبات رسالة تنبيه إلى جيرانها وتتلقى رسالة تنبيه من جيرانها ، مما يتسبب في زيادة عدد الرسائل المعاد بثها ويؤدي إلى حدوث فيضان. سيؤدي الفيضان إلى زيادة استخدام النطاق الترددي ، وإسقاط الحزم وما إلى ذلك ، كما أن التعامل مع حالة الفيضان هذه مسألة مفتوحة. وبالتالي ، تقترح هذه الورقة تقنية جديدة للتحكم في إعادة بث رسائل الطوارئ لتقليل عدد الرسائل التي يتم بثها أو إعادة بثها في VANET. على عكس طريقة إعادة البث التقليدية ، تم أخذ الطبيعة متعددة المسارات لنشر الإشارات المتأصلة في البيئة الحضرية في الاعتبار. تتضمن هذه الطريقة تقليل عدد رسائل إعادة البث إلى الحد الأدنى الممكن ، ولكن العدد الكافي لتغطية المعلومات للمنطقة المطلوبة. تم تقييم محاكاة الطريقة المقترحة من حيث النوعية والكمية. إنه يعمل بشكل أفضل من معظم التقنيات الحالية المقترحة.